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(54) Pesticidal dry-form seed treater compositions.

(57) Disclosed is (a) a method for reducing the phytotoxicity of a phytotoxic liquid pest control agent for use in a dry-form seed treater composition, by mixing therewith a mutually insoluble glycol or glycol derivative, (b) a substantially non-phytotoxic, pulverulent, dry-form seed treater composition comprising the phytotoxic liquid pest control agent, the glycol or glycol derivative, and a dry-form, sorptive, agriculturally acceptable carrier, (c) a method for protecting plant seeds and seedlings against plant pests by application of the seed treater composition to the seeds before they are planted, and (d) crop seeds that have been treated with the seed treater composition.

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PESTICIDAL DRY-FORM SEED TREATER COMPOSITIONS

This invention relates to pesticidal dry-form compositions for seed treatment; specifically, to substantially non-phytotoxic pulverulent dry-form seed treater compositions of phytotoxic liquid insecticides or nematicides. The compositions are made substantially non-phytotoxic by the incorporation therein of a liquid glycol or glycol derivative that is substantially insoluble in or does not substantially solubilize the pest control agent.

Over the years, various methods have been employed in attempts to control plant pests that attack seeds and seedlings. Prior to the advent of seed treater compositions, there were few viable alternatives to simply sterilizing the soil by one or more applications of a pesticide just prior to or after planting. Today, the use of pesticide-treated seeds is a frequently used method for protecting agricultural crops during the seed or seeding stage, particularly for grain or vegetable crops.

The use of pesticide-treated seeds advantageously places the pest control agent at the site where pest attack will occur, thereby eliminating the waste attendant upon treating the entire cultivated acreage. Treatment of seeds with a systemic pest control agent affords protection to the seed itself, to emerging roots and upward growth of seedlings vulnerable to attack by soil borne insects and nematodes, and to seedlings newly emergent from the soil which are especially vulnerable to attack by above-ground insects and other pests.

Because use of a seed treater composition necessarily brings the components of the composition in close physical contact with the seeds to be treated, great care must be exercised in selecting components that would not be phytotoxic to the seeds or seedlings. Since a wide variety of non-phytotoxic adjuvants, carriers, and other miscellaneous inert ingredients for

seed treater compositions are known in the art, selection of appropriate non-phytotoxic additives may usually be made without difficulty. Thus, it is generally the phytotoxic propensity of the pest control agent itself
5 that is the limiting factor in designing a composition for seed treatment, and is determinative of the viability of that particular form of application for the compound.

Generally, crystalline or otherwise solid pesticides, when applied in that form to seeds, are not
10 phytotoxic and may safely be used in various conventional seed treater compositions. Many liquid pest control agents, however, are phytotoxic to seeds and seedlings, and have not heretofore been suitable candidates for seed treatment use. Being liquids, these
15 materials are in a form readily absorbed by the seed which is thereby made particularly vulnerable to any phytotoxic property of the pesticide. A phytotoxic effect is usually evidenced by a reduced germination
20 rate of treated seeds or by an inhibition of seedling growth.

Seed treater compositions are either liquid or solid (dry) compositions. Liquid seed treater compositions are usually slurries or suspensions of the active
25 ingredient, adhesive sticker or binder, and various adjuvants in a liquid carrier, frequently water. There are a number of disadvantages to using liquid seed treater compositions that are generally not encountered with dry-form compositions. The larger number of
30 ingredients commonly used in liquid compositions generally makes them more expensive than dry-form compositions. Also, special equipment may be needed for applying liquid compositions to the seeds, a separate step for drying the treated seeds may be necessary, and
35 liquid compositions frequently develop stability problems upon storage for long periods of time.

Dry-form seed treater compositions are basically homogeneous powdery mixtures of pest control agent, binder, and dry carrier. Usually, they will also contain one or more of various adjuvants. Like liquid-form compositions, dry-form compositions also present certain
5 problems. They tend to be dusty, as do seeds treated with them. In addition to being unpleasant for personnel who prepare the compositions or handle the treated seeds, dustiness increases exposure to inherent hazards of the pesticide. Also, in many cases, especially where
10 a high loading rate is desired, seeds must be treated with water or some other liquid prior to application of a dry-form seed treater composition to aid in binding the composition to the seed. Furthermore, binding agents frequently used in dry-form compositions such
15 as the compositions disclosed in British Patent No. 830,655, published March 16, 1960, are mineral or vegetable oil-based materials and are unsuitable for use with phytotoxic liquid pesticides. Such oils have an affinity for many seeds and are generally miscible
20 with many commercially available liquid pesticides. They can thereby act as a vehicle for dissolving the pesticide and bringing it into contact with the seeds.

In the present invention certain liquid glycols or glycol derivatives are effective binding agents for
25 dry-form seed treater compositions; and, where the pesticide component of the seed treater composition is a liquid phytotoxic compound, use in the composition of any such of the glycols or derivatives that are substantially mutually insoluble in the phytotoxic ingredient
30 will effectively safen the composition for seed treatment use by protecting the seed against the phytotoxicity of the pest control agent. Moreover, inclusion of such glycol or glycol derivative binder-safener in a dry-form seed treater composition as described herein
35 results in a low-dust composition that may be applied dry to seeds without the need for prewetting or pre-

treating the seeds. The pesticide-treated seeds are prepared by mixing the composition and seeds together, thereby forming a low-dust adherent coating on the seeds, the pest control agent being dispersed in the adherent coating. The pest control agent comprises from 0.1% to 1.0% or 2.0% of the total weight (seed plus coating) of the treated seeds. The percent by weight of the pest control agent on the seeds is referred to herein as the loading rate.

10 According to this invention there is provided (a) a method for reducing the phytotoxicity of a phytotoxic liquid pest control agent for use in a dry-form seed treater composition, by mixing therewith a safener-binder glycol or glycol derivative; (b) a substantially
15 non-phytotoxic, pulverulent, dry-form seed treater composition comprising the phytotoxic liquid pest control agent, the safener-binder, and a dry-form, sorptive, agriculturally acceptable carrier; (c) a method for protecting plant seeds and seedlings against
20 plant pests by application of the seed treater composition to the seeds before they are planted, and (d) seeds that have been treated with the seed treater composition.

The term "dry-form" as used herein means solid form as opposed to liquid form, and does not relate to the presence or absence of water. The term "pulverulent"
25 means consisting of or reducible to a powder. "Phytotoxic" or "non-phytotoxic" refers to the presence or absence of phytotoxicity to seeds or seedlings. "Ambient temperature" for a material is any temperature
30 in the range of temperatures normally encountered during use of the material for its intended purpose. Ambient temperature for a pest control agent, alone or in admixture with one or more other materials, will usually be a temperature in the range of about 10° to
35 50°C.

The present seed treater compositions are substantially non-phytotoxic, pulverulent, dry-form composi-

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tions, and are comprised by weight of

- (a) from 1 to 50% of a phytotoxic liquid pest control agent,
- 5 (b) from 5 to 60% of a glycol or glycol derivative selected from the group consisting of ethylene glycol, propylene glycol, trimethylene glycol, glycerol, a polyethylene glycol having a molecular weight in the range of about 100 to 600, a polypropylene glycol having a molecular weight in the range of about 200 to 1000, a block polymer of ethylene oxide and propylene oxide having a molecular weight in the range of about 1000 to 5000 and a viscosity in the range of about 150 to 800 cps at a temperature in the range of about 25° to 60°C, and a poly(alkylene of 2 to 4 carbon atoms) glycol ether of a primary or secondary alcohol of 5 to 15 carbon atoms or of octylphenol or nonylphenol, the poly-alkylene glycol ether having a molecular weight in the range of about 300 to 4000 and a viscosity in the range of about 200 to 4000 cps at a temperature in the range of about 25° to 60°C,
- 10 with the proviso that the glycol or glycol derivative is substantially insoluble in or does not substantially solubilize the pest control agent at ambient temperature, and
- 15 (c) sufficient dry-form, sorptive, agriculturally acceptable carrier to produce a pulverulent dry-form composition.
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The present dry-form seed treater compositions, while suitable for use with most pest control agents, are designed especially for use with phytotoxic liquid pest control agents, primarily insecticides or nematocides that are liquids at ambient temperature. A preferred pest control agent is carbosulfan, a commercial systemic insecticide-nematicide. Carbosulfan, the common name of 2,3-dihydro-2,2-dimethyl-7-benzofuranyl [(di-n-butyl)aminosulfenyl][methyl]carbamate, is an

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N-sulfenylated derivative of the commercial insecticide carbofuran, and is disclosed in U.S. Patent No.

4,006,231. Other phytotoxic liquid N-substituted derivatives of carbofuran, including other N-sulfenyl derivatives such as 2,3-dihydro-2,2-dimethyl-7-benzofuranyl[bis(ethoxycarbonylmethyl)aminosulfonyl][methyl]-carbamate, may also be suitably used in the present invention. Carbofuran is the common name of 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate, and is described in U.S. Patent No. 3,474,171. Other preferred pest control agents include terbufos (S-tert-butylthiomethyl-O,O-diethyl phosphorodithioate), fonofos (O-ethyl-S-phenyl ethylphosphonodithioate), and phorate (O,O-diethyl-S-ethylthiomethyl phosphorodithioate).

The pest control agent comprises by weight from 1 to 50%, preferably 10 to 50%, of the composition. In most cases, the concentration will be in the range of 10 to 35%, most frequently 20 to 30%. Examples 2 and 3 below describe the preparation of 25% w/w carbosulfan compositions, and Example 4 describes the preparation of a 30% w/w carbosulfan composition.

The glycol or glycol derivative component of the present seed-treater composition is a multipurpose ingredient. It functions as a dedusting agent and, if it's a polyhydroxy compound, as an "acidic hot-spot" deactivator for dry silicate carriers. Its primary functions, however, are as a binding agent for adhering the composition to the seeds, and as a safening agent for reducing the phytotoxicity of the pest control agent to the seeds and seedlings.

The glycol or glycol derivative is advantageously incorporated into the seed treater composition by spraying the material into a blender or mixer containing a mixture of pest control agent and dry carrier. Thus, the binder-safener should be a sprayable liquid at ambient conditions or with slight heating, for example, up to about 60°C. A preferred binder-safener is poly-

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ethylene glycol having a molecular weight of about 400.

The binding function of the binder-safener requires use of more of the material than would otherwise be needed for effective safening, and the presence in the composition of a sufficient amount for binding will also give adequate safening. Depending on the inherent pesticidal activity of the pest control agent used, it may be necessary, for effective pest control, to have a loading rate of the pest control agent on the seeds in the range of about 0.1 to 2.0% w/w, usually 0.1 to 1.0% w/w, based on the weight of the treated seeds. To achieve such loading rates, the binder-safener will comprise by weight from 5 to 60%, usually 20 to 50%, of the composition, depending, of course, on the concentration of pest control agent in the composition, the bulk of the dry carrier and possibly other additives, and the surface texture of the seeds. Where a high loading rate is desired, or where the seeds to be treated have a smooth surface texture which hinders effective binding, it is advantageous to employ a high concentration of the pest control agent in the composition and to use a highly sorptive carrier, thereby decreasing the bulk of the composition to be applied to the seeds.

The carrier in the present seed treater compositions should be an inert, agriculturally acceptable (non-phytotoxic), sorptive material, capable of absorbing or adsorbing relatively large volumes of liquid. It may be a naturally occurring material or a synthetic material. Silicas and silicates are particularly suitable; especially precipitated silica, hydrous calcium silicate, and the various hydrous aluminum/magnesium silicates and mixtures commonly used in the art such as attapulgite, kaolin, montmorillonite, talc, pyrophyllite, and diatomite. A preferred carrier, because of its very high sorptive capacity, is hydrous calcium silicate.

The amount of carrier used should be a quantity sufficient to produce a pulverulent dry-form composition. Usually, this will be an amount equal to about 10 to 70%, more frequently about 25 to 50%, of the weight
5 of the composition, depending upon such factors as the sorptive capacity of the selected carrier and the desired concentration of active ingredient.

Many dry carriers, especially silica based materials, contain acid-active sites ("acidic hot-spots")
10 which may catalyze the decomposition of acid labile materials they come in contact with. A number of commercially available pesticides, including carbosulfan, are known to be acid sensitive, and may decompose over a period of time in the presence of such centers of
15 acidic activity. Therefore, depending upon the nature of the carrier and the pest control agent used, the present seed treater compositions may advantageously contain an acid neutralizing agent or deactivator. The deactivator may be any of various alcohols, amines,
20 ketones, or mildly basic organic compounds commonly used for that purpose in the art. Polyhydroxy compounds, such as diethylene glycol or other glycols, are preferred. If the binder-safener component of the composition is a polyhydroxy compound, inclusion of a separate
25 material in the composition for deactivation purposes would not be necessary. In general, an acidic hot-spot deactivator, separate from the binder-safener component, will comprise by weight about 0 to 10% of the present compositions, usually about 0 to 3%.

30 The present seed treater compositions may also contain various amounts of other adjuvants or inert ingredients. Many pest control agents spontaneously decompose in the presence of light, air, or moisture and have an unacceptably short shelf life. The insecticide
35 carbosulfan and other N-sulfenylated derivatives of carbofuran have been reported to decompose slowly to give carbofuran as a decomposition product. Organo-

phosphates and related insecticides are also susceptible to decomposition upon standing. Various chemical stabilizers are available for addition to pesticidal compositions to stabilize them against such spontaneous decomposition, and may advantageously be used in the present compositions. Frequently, for organophosphates and related materials, and for the N-sulfenylated derivatives of carbofuran such as carbosulfan, the chemical stabilizer will be an antioxidant, generally an epoxide compound. Epoxidized soybean oil is a preferred stabilizer for use herein with carbosulfan or related compounds. Other especially desirable stabilizers are disclosed in U.S. Patent No. 4,281,014, incorporated herein by reference. When a chemical stabilizer is used it will generally comprise by weight about 0.01 to 20% of the composition. Most frequently, particularly where epoxidized soybean oil is used to stabilize carbosulfan, the amount of stabilizer used will be in the range of about 2 to 8%.

A dye or pigment such as methylene blue or rhodamine B may also be included in the present compositions, so that the treated seeds may be readily recognized or identified by a distinctively colored coating. Generally, a dye or pigment will comprise by weight from 0 to 5% of the composition. Examples 3 and 4 below describe the preparation of seed treater compositions containing 1% w/w of rhodamine B.

In preparing the present seed treater compositions, the pest control agent may be incorporated as technical grade material or, more conveniently, as a solid base formulation. Solid base formulations of commercial insecticides are admixtures of the technical grade pesticide with a dry carrier and other adjuvants. They have improved handling characteristics over the undiluted technical material, and are generally used as solid stock formulations for preparing granular or other types of formulations. A solid base formulation of

carbosulfan will generally contain by weight from about 10 to 60% of technical grade carbosulfan, from about 5 to 70% of a dry-form, sorptive carrier, and optionally, various amounts of adjuvants such as a chemical stabilizer, dispersing agent, dye or pigment, acidic hot-spot deactivator, and other additives. A typical carbosulfan solid base formulation containing approximately 40% w/w active ingredient, useful in the preparation of the present compositions, is described in Example 1 below.

In applying the present seed treater compositions to seeds, no special equipment is required, and it is not necessary to pretreat or prewet the seeds; the seeds and seed treater composition are merely mixed together in a container until the dry composition is completely and uniformly distributed over the surface of the seeds. Mechanical mixing or rolling is preferred but not necessary. In some instances, it may be advantageous for cosmetic purposes to pretreat the seeds with a little water or other suitable liquid, and apply the seed treater composition to the wetted seeds. Generally, about 2% of the liquid, based on the weight of the seeds before treatment, is sufficient to wet the seeds.

Treatment of seeds before they are planted with an insecticidally or nematocidally effective amount of a seed treater composition of this invention will protect the seeds and seedlings against insects or nematodes. The insect or nematode control agent will generally comprise from 0.1% to 1.0% or 2.0% of the weight of the treated seeds. The present compositions may be used with crop seed used in agriculture, for example, rice, wheat, sorghum, corn, barley, cotton, sugar beets, rape, dry beans, soybeans, flax, alfalfa, sunflower, and peanuts, particularly rice. Many seed processors or vendors treat their seeds with one or more pesticides, generally a fungicide and/or an insecticide, to protect the seeds during periods of storage. As a rule, most

commercially available seeds useful in the practice of this invention will have been treated in this manner. Such treatment is ineffective in giving adequate protection to the seeds after planting, and is not a
5 substitute for seed treatment of the present type.

Another aspect of the present invention comprises a method of reducing the phytotoxicity of a phytotoxic liquid pest control agent for use in a dry-form seed treater composition, by mixing the pest control agent
10 with a glycol or glycol derivative discussed above, preferably polyethylene glycol having a molecular weight of about 400. A preferred pest control agent is the insecticide-nematicide carbosulfan. The glycol or glycol derivative is employed in an amount equal to 0.1
15 to 60 times the amount by weight of the phytotoxic liquid pest control agent present. Usually, the amount will be 0.4 to 5, more frequently 0.4 to 2, times the amount of pest control agent used.

The following examples, which are intended to be
20 illustrative of the present invention, describe in detail the preparation of seed treater compositions of the invention and application of them to seeds. In the examples, the words "seed treater" are frequently used in their abbreviated form "ST" for convenience.

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Example 1Preparation of 40% W/W Carbosulfan Solid Base
Formulation

		Amount	
<u>Ingredients</u>		<u>% W/W</u>	<u>(kg)</u>
5	Carbosulfan (89% Technical - Contains 4% Epoxidized Soybean Oil)	45.39	123.55
	Diethylene Glycol, Deactivator	2.00	5.45
	Epoxidized Soybean Oil, Stabilizer	3.20	8.71
10	Sugar-Free Sodium-Based Ligno- sulfonates, Dispersant	2.50	6.81
	Sorptive Hydrous Calcium Silicate, Carrier	<u>46.91</u>	<u>127.72</u>
Total		100.00%	272.24 kg

The equipment required for preparation of a 272.24
15 kg (600 lb) batch of carbosulfan 40% solid base consists
of a ribbon blender fitted with nozzles, an impregnation
tank with an agitator and pump, an attrition mill, and
associated scales, hoppers, elevators, hoods, and dust
collection equipment.

20 The calcium silicate, 127.72 kg, was added to an
operating ribbon blender. Diethylene glycol, 5.45 kg,
was added to an impregnation tank, and sprayed into the
ribbon blender. The stabilized carbosulfan, 123.55 kg,
and the epoxidized soybean oil, 8.71 kg, were thoroughly
25 mixed in an impregnation tank, then sprayed into the
calcium silicate-diethylene glycol mixture in the ribbon
blender at such a rate to ensure even distribution.
To this mixture was added 6.81 kg of sugar-free sodium-
based lignosulfonates. The formulation was mixed for 10
30 minutes, then passed through an attrition mill.

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Example 2Preparation of 25% W/W CarbosulfanST Formulation (Formulation 2)

			Amount
5	<u>Ingredients</u>	<u>% W/W</u>	<u>(kg)</u>
	Carbosulfan 40% Solid Base	62.50	2.50
	Polyethylene Glycol - 400 Mol. Wgt.	<u>37.50</u>	<u>1.50</u>
	Total	100.00%	4.00 kg

Carbosulfan 40% solid base, 2.50 kg, was placed in
 10 a ribbon blender and sprayed with 1.50 kg of polyethyl-
 ene glycol having a molecular weight of about 400. The
 combination was mixed thoroughly for ninety minutes.

Example 3Preparation of 25% W/W CarbosulfanST Formulation Containing a Dye (Formulation 3)

			Amount
	<u>Ingredients</u>	<u>% W/W</u>	<u>(g)</u>
	Carbosulfan 40% Solid Base	64.0	64.0
	Polyethylene Glycol - 400 Mol. Wgt.	35.0	35.0
20	Rhodamine B	<u>1.0</u>	<u>1.0</u>
		100.00%	100.0 g

Carbosulfan 40% solid base, 64.0 g, and rhodamine
 B, 1.0 g, were placed in a blender, and blended at high
 speed for two minutes. Polyethylene glycol of about 400
 25 molecular weight, 35.0 g, was added, and the mixture was
 blended at high speed until homogeneous.

Example 4Preparation of 30% W/W CarbosulfanST Formulation Containing a Dye (Formulation 4)

			Amount
30	<u>Ingredients</u>	<u>% W/W</u>	<u>(g)</u>
	Carbosulfan 40% Solid Base	75.0	75.0
	Polyethylene Glycol - 400 Mol. Wgt.	24.0	24.0
	Rhodamine B	<u>1.0</u>	<u>1.0</u>
35	Total	100.0%	100.0 g

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Carbosulfan 40% solid base, 75.0 g, was placed in a blender and blended at high speed while a mixture of 24.0 g of polyethylene glycol of about 400 molecular weight and 1.0 g of rhodamine B was added slowly in 5 g aliquots. Upon complete addition, the mixture was 5 blended at high speed until homogeneous.

Example 5

Application of Carbosulfan 25% ST (Formulation 2)
to Rice Seed for 1% Carbosulfan Load

Seed Lots 5A, 5B, and 5C

10	<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (kg)</u>
	Lebonnet Rice Seed	96.00	20.64
	Carbosulfan 25% W/W ST Formulation	<u>4.00</u>	<u>0.86</u>
	Total	100.00%	21.50 kg

The rice seed, 20.64 kg, was de-dusted by tumbling 15 the seed under a vacuum hose for two minutes.

Carbosulfan 25% W/W seed treater formulation (Formulation 2, Example 2), 0.86 g, was mixed thoroughly with the de-dusted rice seed in a cement mixer for thirty minutes. Batch lots of 0.91 kg each were removed 20 for germination studies at ten minute intervals during the thirty minute mixing period.

	<u>Lot</u>	<u>Mixing Time (Minutes)</u>
	5A	10
	5B	20
25	5C	30

Example 6

Application of Carbosulfan 25% ST (Formulation 2)
to Cotton Seed for 1% Carbosulfan Load

Seed Lots 6A and 6B

30 A. Seed Lot 6A: Acid-Delinted Cotton Seed

	<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
	Acid-Delinted Cotton Seed	96.0	125.0
	Carbosulfan 25% W/W ST Formulation	<u>4.0</u>	<u>5.2</u>
	Total	100.0%	130.2 g

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Acid-delinted cotton seed, 125.0 g, was placed in a 0.95 liter jar, and 5.2 g of carbosulfan 25% w/w seed treater formulation (Formulation 2, Example 2) was added. The mixture was rolled until the seed treater formulation was uniformly dispersed on the seed surface.

B. Seed Lot 6B: Machine-Delinted Cotton Seed

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Machine-Delinted Cotton Seed	96.0	125.0
Carbosulfan 25% W/W ST Formulation	4.0	5.2
Total	100.0%	130.2 g

The procedure above (6A), using Formulation 2 (Example 2), was repeated here to produce 130.2 g of machine-delinted cotton seed having a 1% w/w load of carbosulfan.

Example 7

Application of Carbosulfan 25% ST (Formulation 3)
to Wheat Seed for 0.5% Carbosulfan Load

Seed Lots 7A and 7B

A. Seed Lot 7A: Pre-treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	98.0	490.0
Carbosulfan 25% W/W ST Formulation	2.0	10.0
Total	100.0%	500.0 g

Wheat seed, 490.0 g, was placed in a 0.95 liter jar, and 9.8 g of water was added (2% based on weight of seed). The jar was mechanically rolled until all the seed was completely wetted.

Carbosulfan 25% w/w seed treater formulation (Formulation 3, Example 3), 10.0 g, was added to the wetted seed in the jar, and rolling was continued until the seed treater formulation was uniformly dispersed on the seed surface (about ten minutes).

B. Seed Lot 7B: No Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	98.0	490.0
Carbosulfan 25% W/W ST Formulation	2.0	10.0
Total	100.0%	500.0 g

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Wheat seed, 490.0 g, was placed in a 0.95 liter jar, and 10.0 g of carbosulfan 25% w/w seed treater formulation (Formulation 3, Example 3) was added. The mixture was rolled until the seed treater formulation was uniformly dispersed on the seed surface.

Example 8

Application of Carbosulfan 25% ST (Formulation 3)
to Wheat Seed for 1% Carbosulfan Load

Seed Lots 8A and 8B

10 A. Seed Lot 8A: Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	96.0	480.0
Carbosulfan 25% W/W ST Formulation	<u>4.0</u>	<u>20.0</u>
Total	100.0%	500.0 g

15 The seeds were treated in the manner described in Example 7A, using 9.6 g of water (2% based on weight of seed) to wet the seed prior to application of the seed treater formulation, Formulation 3 from Example 3.

B. Seed Lot 8B: No Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	96.0	480.0
Carbosulfan 25% W/W ST Formulation	<u>4.0</u>	<u>20.0</u>
Total	100.0%	500.0 g

The seeds were treated in the manner described in Example 6, using seed treater Formulation 3 from Example 3.

Example 9

Application of Carbosulfan 30% ST (Formulation 4)
to Wheat Seed for 0.5% Carbosulfan Load

30 Seed Lots 9A and 9B

A. Seed Lot 9A: Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	98.3	491.5
Carbosulfan 30% W/W ST Formulation	<u>1.7</u>	<u>8.5</u>
Total	100.0%	500.0 g

The seeds were treated in the manner described in Example 7A, using 9.8 g of water (2.0% based on weight of seed) to pre-wet the seed. Formulation 4 (Example 4) was the seed treater formulation used.

5 B. Seed Lot 9B: No Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	98.3	491.5
Carbosulfan 30% W/W ST Formulation	<u>1.7</u>	<u>8.5</u>
Total	100.0%	500.0 g

10 The seeds were treated in the manner described in Example 6, using seed treater Formulation 4 from Example 4.

Example 10

Application of Carbosulfan 30% ST (Formulation 4)
15 to Wheat Seed for 1% Carbosulfan Load

Seed Lots 10A and 10B

A. Seed Lot 10A: Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	96.6	483.0
20 Carbosulfan 30% W/W ST Formulation	<u>3.4</u>	<u>17.0</u>
Total	100.0%	500.0 g

The seeds were treated in the manner described in Example 7A, using 9.5 g of water (1.9% based on weight of seed) to pre-wet the seed. Formulation 4 (Example 4) was the seed treater formulation used.

25 B. Seed Lot 10B: No Pre-Treatment with Water

<u>Ingredients</u>	<u>% W/W</u>	<u>Amount (g)</u>
Ticonderoga Wheat Seed	96.6	483.0
Carbosulfan 30% W/W ST Formulation	<u>3.4</u>	<u>17.0</u>
30 Total	100.0%	500.0 g

The seeds were treated in the manner described in Example 6, using seed treater Formulation 4 from Example 4.

Example 11

35 Seed Germination Studies

Seeds treated with seed treater formulations of this invention were tested for germination viability.

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The tests were conducted by the National Seed Testing Service, 2042 Birchwood Avenue, Toledo, Ohio 43614, using procedures formulated by the Association of Official Seed Analysts and set forth in their "Rules For
 5 Testing Seeds", Proceedings of the Association of Official Seed Analysts, Volume 60, No. 2, 1970. Germination data were obtained for treated seeds that had been stored for a period of 0 (Initial), 1, 3, 6, or 12
 10 months at 70°F and 20-25% relative humidity. Storage time does not include transit time (generally less than one week) from Middleport, New York, where the treated seeds were prepared.

Procedure:

Upon receipt of the treated seeds or expiration of
 15 the appropriate storage time, four replicates of 100 seeds each were placed on non-phytotoxic paper towels soaked with distilled water. The towels were formed into rolled packages containing the seeds, and were kept wet with distilled water throughout the germination
 20 test. Depending on the type of seed used, the seed-towel packages were allowed to stand for 7 to 14 days at a temperature in the range of 20° to 30°C and a relative humidity of 95%:

	<u>Seed</u>	<u>Temperature</u>	<u>Duration (days)</u>
25	Rice ¹	20°C/16 hr. 30°C/8 hr.	14
	Cotton ¹	20°C/16 hr. 30°C/8 hr.	12
30	Wheat	20°C	7

1 - Temperature cycled each 24 hr.

The percent germination was determined by averaging the actual percent germination for the four replicates of each sample. These data are shown in the following
 35 table. Germination data for unstored treated seeds are given in the table as "Initial" data.

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Germination Data

	<u>Seed Lot No.</u>	<u>Seed</u>	% Carbo- sulfan on Seed	% Germination				
				<u>Init.</u>	<u>1 Mo.</u>	<u>3 Mo.</u>	<u>6 Mo.</u>	<u>12 Mo.</u>
5	5A	Rice	1.0	—	—	79	77	73
	5B	Rice	1.0	—	79	81	78	62
	5C	Rice	1.0	—	80	76	75	68
	Carbosulfan only ¹	Rice	1.0	68	72 ²	64	—	—
	Untreated check	Rice	0	77	83	88	86	—
10	6A	Cotton ³	1.0	93	—	94	—	—
	Untreated check A	Cotton ³	0	93	—	94	—	—
	6B	Cotton ⁴	1.0	80	—	93	—	—
	Untreated check B	Cotton ⁴	0	79	—	85	—	—
	7A	Wheat	0.5	97	97	97	—	—
15	7B	Wheat	0.5	98	98	98	—	—
	8A	Wheat	1.0	98	98	95	—	—
	8B	Wheat	1.0	97	96	97	—	—
	9A	Wheat	0.5	98	97	98	—	—
	9B	Wheat	0.5	97	97	97	—	—
20	10A	Wheat	1.0	96	98	92	—	—
	10B	Wheat	1.0	97	98	97	—	—
	Carbosulfan only ¹	Wheat	0.5	75	79	72	—	—
	Carbosulfan only ¹	Wheat	1.0	62	35	55	—	—
	Untreated check	Wheat	0	—	97	98	—	—

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1 - Seeds were treated only with carbosulfan technical

2 - Treatment inhibited seedling growth

3 - Acid delinted

4 - Machine delinted

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CLAIMS

1. A substantially non-phytotoxic, pulverulent, dry-form seed treater composition containing a phytotoxic liquid pest control agent suitable for application to plant seeds to protect seeds and seedlings against insects or nematodes, containing, by weight
- 5 (a) from 1 to 50% of a phytotoxic insect or nematode pest control agent that is a liquid at ambient temperature,
- (b) from 5 to 60% of a binder-safener that is ethylene glycol, propylene glycol, trimethylene glycol, glycerol, a polyethylene glycol having a molecular weight in the range of 100 to 600, a polypropylene glycol having a
- 10 molecular weight in the range of 200 to 1000, a block polymer of ethylene oxide and propylene oxide having a molecular weight in the range of 1000 to 5000 and a viscosity in the range of 150 to 800 mPa.s at a temperature in the range of 25° to 60° C, or a poly(C₂₋₄ alkylene) glycol ether of a C₅₋₁₅ primary or secondary alcohol or of octylphenol or nonylphenol, the
- 15 polyalkylene glycol ether having a molecular weight in the range of 300 to 4000 and a viscosity in the range of 200 to 4000 mPa.s at a temperature in the range of 25° to 60° C, with the proviso that the glycol or glycol derivative is substantially insoluble in or does not substantially solubilize the pest control agent at ambient temperature, and
- 20 (c) sufficient solid sorptive agriculturally acceptable carrier to produce a pulverulent solid composition.
2. A composition as claimed in Claim 1 in which the pest control agent is an N-substituted derivative of 2,3-dihydro-2,2-dimethylbenzofuran-7-yl
- 25 methylcarbamate.
3. A composition as claimed in Claim 2 in which the pest control agent is an N-(sulfenyl) derivative of 2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate.
- 30 4. A composition as claimed in Claim 3 in which the pest control agent is 2,3-dihydro-2,2-dimethyl-7-benzofuranyl [(di-n-butyl)aminosulfenyl]-[methyl]carbamate or 2,3-dihydro-2,2-dimethyl-7-benzofuranyl[bis(ethoxy-carbonylmethyl)aminosulfenyl][methyl]carbamate.

5. A composition as claimed in Claim 4 containing by weight
- (a) from 10 to 50% of the pest control agent 2,3-dihydro-2,2-dimethyl-7-benzofuranyl[(di-n-butyl)aminosulfonyl][methyl]carbamate,
- (b) from 20 to 50% of the binder-safener, and
- 5 (c) sufficient carrier to produce the pulverulent solid composition.
6. A composition as claimed in any one of Claims 1 to 5 containing from 0.01 to 20% by weight of a chemical stabilizer epoxide compound.
- 10 7. A composition as claimed in any one of Claims 1 to 6 in which the pest control agent makes up from 10 to 35% by weight of the composition.
8. A composition as claimed in Claim 7 in which the pest control agent makes up from 20 to 30% by weight of the composition.
- 15 9. A composition as claimed in any one of Claims 1 to 8 in which the dry-form carrier makes up from 10 to 70% by weight of the composition.
10. A composition as claimed in Claim 9 in which the dry-form carrier makes up from 25 to 50% by weight of the composition.
- 20 11. A composition as claimed in any one of Claims 1 to 10 in which the binder-safener is polyethylene glycol having a molecular weight of about 400.
- 25 12. A composition as claimed in any one of Claims 1 to 5 in which the carrier is precipitated silica, hydrous calcium silicate, or a hydrous aluminum/magnesium silicate or mixture thereof. --
- 30 13. A composition as claimed in Claim 12 in which the carrier is hydrous calcium silicate.
14. A composition as claimed in Claim 6 in which the pest control agent makes up from 10 to 35% by weight of the composition, the chemical stabilizer epoxide compound is epoxidized soybean oil, the binder-safener is polyethylene glycol having a molecular weight of about 400, and the carrier
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makes up from 10 to 70% by weight of the composition and is precipitated silica, hydrous calcium silicate, or a hydrous aluminum/magnesium silicate or mixture thereof.

- 5 15. A composition as claimed in Claim 14 in which the pest control agent makes up from 20 to 30% by weight of the composition and the carrier makes up from 25 to 50% by weight of the composition and is hydrous calcium silicate.
- 10 16. A method of protecting plant seeds and seedlings against insect or nematode pests comprising applying to the seeds, before they are planted, an insecticidally or nematicidally effective amount of a seed treater composition as claimed in any one of Claims 1 to 15.
- 15 17. A method as claimed in Claim 16 in which the seed treater composition is applied in such an amount as to give treated seeds where the weight of pest control agent is from 0.1 to 2.0% of the total weight of the treated seeds.
- 20 18. A method as claimed in Claim 17 in which the weight of pest control agent is from 0.1 to 1.0% of the total weight of the treated seeds.
- 25 19. A method as claimed in Claim 16, 17 or 18 in which the seeds to be protected are first wetted with water and the seed treater composition is applied to the wetted seeds.
- 30 20. A method of reducing the phytotoxicity of a phytotoxic liquid insect or nematode pest-control agent for use in a dry-form seed-treater composition comprising mixing with it a binder-safener as defined in Claim 1 section (b), the amount of binder-safener being 0.4 to 5 times the amount by weight of the phytotoxic liquid pest-control agent present.
- 35 21. A method as claimed in Claim 20 in which the amount of binder-safener is 0.4 to 2 times the amount by weight of the phytotoxic liquid pest-control agent present.

22. A method as claimed in Claim 20 or 21 in which the pest control agent is 2,3-dihydro-2,2-dimethyl-7-benzofuranyl[(di-n-butyl)amino-sulphenyl][methyl]carbamate.
- 5 23. A method as claimed in any one of Claims 20 to 22 in which the binder-safener is polyethylene glycol having a molecular weight of about 400.
- 10 24. Crop seed protected against insects or nematodes by an adherent coating containing an insect or nematode pest control agent in which the coating is obtained by applying a seed treater composition of any one of Claims 1 to 15 to the seeds to be protected.
- 15 25. Seed as claimed in Claim 24 in which the insect or nematode pest control agent makes up from 0.1 to 2.0% of the total weight of the protected seed.
- 20 26. Seed as claimed in Claim 25 in which the insect or nematode pest control agent makes up from 0.1 to 1.0% of the total weight of the protected seed.
27. Seed as claimed in any one of Claims 24 to 26 that is rice, cotton, or wheat seed.